APPARATUS FOR MULTI-LEVEL LOOPBACK TEST
IN A COMMUNITY NETWORK SYSTEM AND METHOD THEREFOR

FIELD OF THE INVENTION

5   The present invention relates to network and more particularly to an apparatus for multi-level loopback test in a community network system and method therefor.

BACKGROUND OF THE INVENTION

10   In recent years, Internet has been widely employed worldwide. In particular, the World Wide Web (WWW) of Internet can provide voice, graphics, and multimedia services in addition to e-mail transmission and receiving. Hence, people can access a variety of information from WWW. Further, many people take log-on the Internet as a daily work. For accommodating such trend, a

15   variety of high speed network devices have been provided by network equipment manufacturers. Such devices comprise cable modem, asymmetric digital subscriber line (ADSL) modem, etc. Moreover, various associated network peripherals are provided by network equipment manufacturers for enhancing the functionality of network. Such peripherals comprise voice over IP

20   device (VoIP), etc. User can employ VoIP to communicate with a remote user over the Internet so as to greatly reduce long distance or international telecommunication charge.

         Conventionally, a UTP (Unshielded Twisted Pair) based network architecture is selected from a variety of existing network architectures and is

25   widely employed in a community network system as shown in FIG. 1. Each Ethernet adapter 30 at user comprises an ADSL (Asynchronous Digital Subscriber Line) communication interface (not shown) and a router control

circuit (not shown). Ethernet adapter 30 is electrically coupled to an Ethernet equipment (not shown) in central office (or network system communication provider) 34 through router control circuit, UTP based telephone line 31, Ethernet switch 32 of central office 34 installed in a community, and optical fiber 33. The Ethernet equipment is in turn coupled to the Internet 35 through optical fiber 33. Hence, packets from Ethernet adapters 30 can be transmitted to the Internet 35. Alternatively, packets from the Internet 35 can be received by Ethernet adapters 30. In above network architecture, for example, packets originated from central office 34 are transmitted to each of a certain number of users in community through the high speed optical fiber 33, Ethernet switch 32, and an existing telephone line 31 of each user. As a result, the data transmission of each user is much improved in terms of speed.

In the above mentioned FTTH (Fiber To The Home) or ETTH (Ethernet To The Home) application, there is a long distance between Ethernet switch 32 and central office 34. Hence, network is utilized to perform an online maintenance and management since it is impossible of assigning employees to perform the same. Further, it is impossible to perform a real time online maintenance and management on Ethernet switch 32 by central office 34 because a SNMP (Simple Network Management Protocol) being employed by most network management systems only has limited application. When the system fails, a loopback test is typically conducted to detect which component is malfunctioned. During the loopback test, network management system installed in central office 34 is responsible to issue at least one Ping instruction. Ethernet switch 32 then may reply Ping instruction as it receives the same. Hence, network management system can determine that Ethernet switch 32 fails if there is no reply of the Ping instruction from Ethernet switch 32 within a predetermined period of time. In other words, the only technique employed by network management system is to

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issue a Ping instruction to Ethernet switch 32 for determining whether there is a malfunction from the presence of reply. As to the special problem such as line disconnection, or software in Ethernet switch 32 not normally running, or any other, there is no information about that. Moreover, after network management system has issued a Ping instruction, a good reply means that both hardware and associated software operate normally. Otherwise, it is impossible of obtaining a good reply as well as correctly determining the nature of the fail. For solving the problem, it is typical to assign employees to the site of Ethernet switch 32 to perform a manual maintenance and management. It is disadvantageous because maintenance and management is poor, cost is high, and communication quality is degraded. Thus improvement exists.

SUMMARY OF THE INVENTION

It is therefore an object of the present invention to provide an apparatus for multi-level loopback test in a community network system and method therefor in which a loopback test device is installed between an Ethernet switch in a community and a central office so that the loopback test device can be utilized by network management system in central office to perform a three-level loopback test on the community network system. By utilizing this, it is possible to easily obtain the information of whether there is a fault between central office and loopback test device, whether the connection of Ethernet switch is good, and whether loopback test device operates normally. Hence, the invention has the advantages of no need to assign employees to the site of Ethernet switch to perform a manual maintenance and management, lower cost, and to improve communication quality.

The above and other objects, features and advantages of the present invention will become apparent from the following detailed description taken with

the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 presents schematically the connection of components of network architecture implemented in a conventional UTP based network architecture;

FIG. 2 presents schematically the connection of components of community network system according to the invention;

FIG. 3 is a block diagram of Ethernet switch, loopback test device, and central office of FIG. 2;

FIG. 4 depicts a format of a special BPDU (Bridge Protocol Data Unit) packet issued by network management system during a first level of loopback test according to the invention;

FIG. 5 depicts a format of a reply packet by loopback test device during a first level of loopback test according to the invention;

FIG. 6 depicts a format of a special BPDU (Bridge Protocol Data Unit) packet issued by network management system during a second level of loopback test according to the invention; and

FIG. 7 is a flow chart illustrating network management system in central office how to utilize loopback test device to perform a loopback test on community network system according to a preferred embodiment of the invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIG. 2, there is shown a typical UTP based network architecture. As shown, each user 40 is coupled to an Ethernet switch 42 through an existing telephone line 41. Ethernet switch 42 is coupled to central office 44 and the Internet 45 sequentially through optical fiber 43. Hence,

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packets from users 40 can be transmitted to the Internet 45. Alternatively, packets from the Internet 35 can be received by users 40. The invention installs a loopback test device 46 between Ethernet switch 42 in a community and central office 44. Referring to FIG. 3, loopback test device 46 comprises an

5   Ethernet control circuit 461, a packet transmission and receiving control circuit 462, and at least two I/O ports 463 and 464. Ethernet control circuit 461 is implemented as an FPGA (Field Programmable Gate Array) or ASIC (Application Specific Integrated Circuit). Ethernet control circuit 461 acts to perform loopback test, packet generation, and packet reply. Packet transmission

10 and receiving control circuit 462 is coupled to Ethernet control circuit 461. I/O port 463 is coupled between Ethernet switch 42 and Ethernet control circuit 461, while I/O port 464 is coupled between central office 44 and Ethernet control circuit 461. Therefore, it provides a mechanism needed for I/O ports 463 and 464 to be operated normally and for a variety of inter conversion or buffer to be

15 operated in a full or half duplex mode.

In the invention, central office 44 utilizes loopback test device 46 to conduct a loopback test on community network system in which the loopback test comprises three levels. First level of loopback test acts to determine whether there is a hardware fail between network management system in central office

20 44 and loopback test device 46, and between network management system in central office 44 and Ethernet switch 42. In detail, network management system issues at least one special BPDU packet each having a format as shown in FIG. 4. When Ethernet control circuit 461 of loopback test device 46 receives at least one special BPDU packet, Ethernet control circuit 461 will operate to send the

25 same to packet transmission and receiving control circuit 462. In response, packet transmission and receiving control circuit 462 changes a source address of BPDU packet into a special source address which is in turn sent back to

network management system in central office 44 via Ethernet control circuit 461. The invention fills the reply packet with status information of I/O port 463 coupled to Ethernet switch 42. The status information comprises speed of I/O port 463, full or half duplex, and link status. Hence, network management system in

5 central office 44 can determine whether the line is faulty or not after reply packet has been received. For example, the line is faulty if there is no reply after a predetermined period of time has lapsed. Further, network management system in central office 44 can determine whether I/O port 463 is normally coupled to Ethernet switch 42 in community. The complete format of reply packet is shown

10 in FIG. 5.

Second level of loopback test of the invention acts to determine whether there is a fail between loopback test device 46 and Ethernet switch 42 in community. In detail, network management system issues at least one special BPDU packet each having a format as shown in FIG. 6. When Ethernet control

15 circuit 461 of loopback test device 46 receives a special BPDU packet for enabling a loopback test mode, packet transmission and receiving control circuit 462 will command Ethernet control circuit 461 to enable I/O port 463 coupled to the Ethernet switch 42 in the community enter into the loopback test mode. Hence, all packets sent to I/O port 463 from network management system in

20 central office 44 are sent back to network management system in central office 44 without having any change, resulting in a completion of loopback test. After the completion of loopback test, network management system in central office 44 will issue one (or more) special BPDU packet to finish the loopback test mode. When Ethernet control circuit 461 of loopback test device 46 receives the special

25 BPDU packet, packet transmission and receiving control circuit 462 will command Ethernet control circuit 461 to enable I/O port 463 coupled to the Ethernet switch 42 in the community enter into a normal mode.

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Third level of loopback test of the invention acts to utilize a well known Ping instruction to determine whether there is a hardware and/or software fail between network management system in central office 44 and Ethernet switch 42 in community. The test procedure is well known. Thus a detailed description

5   thereof is omitted herein for the sake of brevity.

Referring to FIG. 3, there is shown a flow chart illustrating network management system in central office 44 how to utilize loopback test device 46 to perform a loopback test on community network system according to a preferred embodiment of the invention. There are three levels of loopback test involved in

10   the community network system as detailed below.

In first level of loopback test (step 10), network management system issues at least one special BPDU packet. Then it is determined whether a reply packet has been received from loopback test device 46 within a predetermined period of time. If yes, then it is determined whether information contained in the reply

15   packet shows that I/O port 463 is normally coupled to Ethernet switch 42 in community. If yes, it means that first level of loopback test is a success, process goes to step 13. Otherwise, process goes to step 11.

In step 11, it is determined whether a reply packet has been received. If yes and process further determines that I/O port 463 is not normally coupled to

20   Ethernet switch 42 in community, process goes to step 12. Otherwise, if there is no reply packet from loopback test device 46 within a predetermined period of time, it means that there is a disconnection between network management system in central office 44 and loopback test device 46.

In step 12, second level of loopback test is performed in which network

25   management system in central office 44 issues at least one special BPDU packet. Then it is determined whether all packets sent to I/O port 463 from network management system in central office 44 are sent back to network

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management system in central office 44 without having any change. If yes, it means that there is a disconnection between loopback test device 46 and Ethernet switch 42 in community or the Ethernet switch 42 in the community is faulty. Otherwise, if not all packets sent to I/O port 463 from network

5   management system in central office 44 are sent back to network management system in central office 44, it means that loopback test device 46 itself is faulty.

In step 13, third level of loopback test is performed in which network management system in central office 44 issues at least one Ping instruction and then further determine whether there is a reply from Ethernet switch 42 in

10   community (which has already received the Ping instruction) within a predetermined period of time. If yes, it means that community network system operates normally. Otherwise, it means that there is a software fail in Ethernet switch 42.

In view of above, network management system of the invention can easily

15   obtain the following information of whether there is a fault between central office and loopback test device, whether the connection of Ethernet switch in community is good, and whether loopback test device operates normally. Hence, the invention has the advantages of no need to assign employees to the site of Ethernet switch to perform a manual maintenance and management, lower cost,

20   and to improve communication quality.

While the invention has been described by means of special embodiments, numerous modifications and variations could be made thereto by those skilled in the art without departing from the scope and spirit of the invention set forth in the claims.